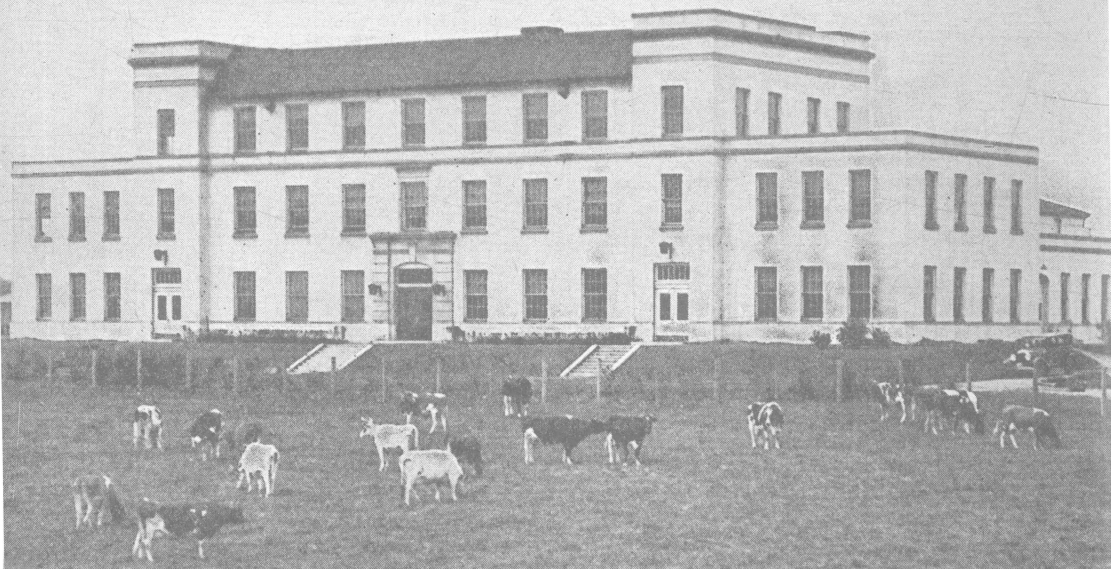
Feeding Dairy Cattle



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CONTENTS

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Feeding Dairy Cattle

By
C. L. BLACKMAN
Extension Dairy Husbandman, The Ohio State University

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NUMEROUS INVESTIGATIONS clearly demonstrate that the higher the production per cow, the lower is the cost of production. The high producing cows actually eat more feed in the course of a lactation, but the amount of feed required to make 100 pounds of milk is less in the case of the higher record cows.

The records of the Ohio Dairy Herd Improvement Association show that the highest producing cows consumed the least feed for each 100 pounds of milk produced. The average amounts of feed for groups of cows arranged according to their milk and butterfat production are shown in Table I.

TABLE I

FEED REQUIRED TO PRODUCE MILK BY COWS OF DIFFERENT PRODUCTION LEVELS

PRODUCTION GROUP *lbs. butterfat*	YEARLY PRODUCTION PER COW		FEED CONSUMED PER 100 LBS. OF MILK PRODUCED				
	Milk *lbs.*	Butterfat *lbs.*	Pasture *days*	Silage *lbs.*	Hay *lbs.*	Stover *lbs.*	Grain *lbs.*
Under 200 lbs...	4,048	164	3.7	127.6	61.7	8.9	40.4
200 to 249.....	5,600	228	2.7	96.7	40.7	6.3	36.3
250 to 299.....	6,664	276	2.0	80.1	34.6	6.3	35.2
300 to 349.....	7,761	324	1.9	70.2	33.0	5.0	34.4
350 to 399.....	8,626	372	1.7	64.1	27.9	4.1	33.9
400 & over.....	10,101	455	1.4	55.2	24.4	2.7	33.3

It should be the aim of every dairyman to so feed his cattle that they make as much milk as they are capable of producing at all times. The average production of dairy cattle in Ohio could be greatly increased by more intelligent feeding. This is shown by the fact that inferior cattle selected by Iowa State College for experimental purposes, when fed liberal balanced rations, made records approximating the average production of Ohio cattle. The experimental cattle made an average production of 3970 pounds of milk and 186 pounds of butterfat. In 1943 the average production of Ohio cattle was 4620 pounds of milk and 189 pounds of butterfat.

FOOD NUTRIENTS

The various constituents of feed which, when taken into the animal body, yield heat or energy, build body tissues, or regulate the body processes are called food nutrients. Energy is required for everything the body does. Tissues are constantly being worn out and replaced, even in the mature body. Certain regulators, like minerals and vitamins, are

necessary for life. In the case of the milking cow, some of all the food nutrients are secreted in the milk.

Definitions and Functions of Food Nutrients

Water.—Water may be considered a food nutrient. It enters into the digestive process. It is a transport medium for food and waste products and a heat regulator. It makes up a large portion of the body secretions. Milk contains about 87.5 per cent of water.

Protein.—Proteins are important organic constituents of all plant and animal cells. They are necessary for body maintenance and growth. Lean meat, eggs, and cheese are common examples of foods high in protein. In digestion, proteins are split up into their "building stones" or amino acids, of which more than twenty-two are known to exist in nature. Some proteins, such as those in milk, meat, fish, and eggs, yield all or nearly all the essential amino acids. Some proteins, like those in cereal grains, are lacking in one or more of the essential ones. The protein in good pasture grass and good quality hay seems to contain good variety of amino acids.

Carbohydrates.—Carbohydrates are widely distributed in feeds and are the principal source of energy. Sugar and starch are common examples of carbohydrates. The animal body contains but a small amount of carbohydrate material, whereas a considerable portion of plants consists of carbohydrates. The animal stores some of this nutrient in the liver and muscle tissue. Some may be transformed into body fat and butterfat.

Fats.—The fats are also widely distributed in feeds. Their general appearance and properties are well known. Like the carbohydrates, the fats serve chiefly as a source of energy. However, they produce 2¼ times as much energy per unit of weight. They may be stored in the animal body and be used to make butterfat.

Ash or Mineral Matter.—The ash, inorganic matter, mineral matter, or salts constitutes only a small portion of the original feed, but is of vital importance. In it are the calcium and phosphorus used in bone formation, the iron and copper used in blood building, and iodine that is so essential for normal development. Other essential inorganic substances are manganese, potassium, sodium, sulfur, chlorine, magnesium, fluorine, and silicon. Plants require these elements in their development, and the cow may secure all of them from good normal feeds. All cattle require common salt. In Ohio, iodine must also be added to the ration, and, under some conditions, phosphorus and calcium must be added.

Vitamins.—These are food substances which are just as essential in feeding and nutrition as proteins, carbohydrates, fats, and minerals.

Normal rations do not lack any of the vitamins necessary for dairy cattle. Good rations contain plenty of the necessary vitamins. However, rations containing low quality roughage may lack a sufficient amount of certain vitamins to maintain growth, health, and efficient production.

We will consider only those vitamins known to be essential for dairy cattle.

Vitamin A is important in dairy cattle feeding. It is necessary for the proper growth and development of calves and young cattle. It is needed in the rations of milking and pregnant cows. It is necessary to maintain health and it plays an important part in maintaining fertility in bulls and cows alike. Cows receiving an abundance of vitamin A or carotene (the material from which vitamin A is made) produce milk rich in this important nutrient. Good pasture is the richest source of this vitamin in cattle rations. Satisfactory amounts are found in good, green, leafy hay, and in corn silage. Good hay crop silage is one of the richest sources of this nutrient.

Vitamin B Complex refers to a group of vitamins found in many of the common feeds. Some of this group are manufactured by micro-

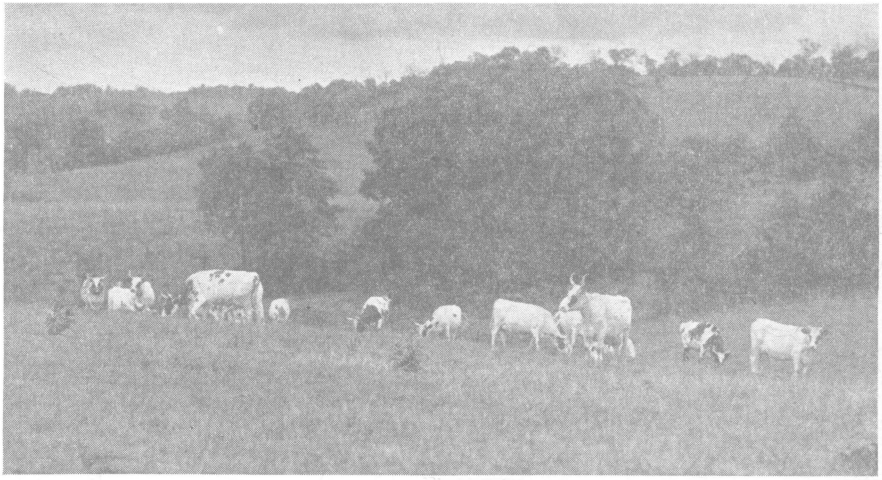

Fig. 1.—This beautiful herd of Ayrshires made an average production of 8435 pounds of milk and 347 pounds of butterfat in 1941-42. Alfalfa hay and improved pasture simplifies the feeding problem on this farm.

organisms (small plants and animals which can only be seen with the aid of a microscope) in the digestive tract. There is some evidence that this group of vitamins should receive consideration in the feeding of young calves.

Vitamin C is essential in reproduction. However, not all reproductive difficulties are due to a lack of this nutrient. Cows are able to manufacture it when the ration is otherwise satisfactory. The practical point in feeding, so far as vitamin C is concerned, is to feed good quality roughage high in vitamin A.

Vitamin E is, unfortunately, sometimes referred to as the "anti-sterility vitamin." It is essential in certain animals. However, it is not necessary for cattle.

Law Requires Statement of Composition of Feed

The Ohio "Feed Stuffs" law is designed to help the purchaser get the food nutrients for which he pays. The following is a quotation from Section 1141 of the "Feed Stuffs" law, and shows the information which the seller of feeds must place on the package:

a. "The net weight of the package, lot, or parcel;
b. The brand name or trademark;
c. The name and principal address of manufacturer or the person responsible for placing the commodity on the market;
d. The minimum percentage of crude protein, allowing 1 per cent of nitrogen to equal 6¼ per cent of protein;
e. The minimum percentage of crude fat;
f. The maximum percentage of crude fiber;
g. The specified name of each ingredient used in its manufacture."

The law requires that the minimum amounts of protein and fat and the maximum amount of fiber be stated. This is to prevent adulteration of feeds with material high in fiber and low in feeding value.

The analysis given below, which was taken from a bag of white hominy feed, shows a typical statement of analysis::

WHITE HOMINY FEED

Protein (min.)	10.0
Fat (min.)	6.0
Carbohydrates (min.)	65.0
Crude fiber (max.)	5.0

(Made from pure white corn)

JOHN DOE
Columbus, Ohio

Dealers in feeds are licensed and inspectors get samples of the feeds offered for sale, to see that analyses do not fall below the statement of guarantee.

Purchasers of feed should always examine the label on feed bags, to be sure that the feed is up to standard.

Characteristics of a Good Ration

Palatability.—High production depends in part upon the cow consuming large amounts of feed. It is important, therefore, that she be given feeds which she likes. While the appetite of the cow may not be as sensitive as that of the human, experienced dairymen know that a cow often has strong likes and dislikes.

Feeds vary widely in their palatability. The cow often has to become accustomed to certain feeds before she will eat them in considerable quantities. When a cow is first turned into sweet clover pasture she seems to eat everything else in the pasture but the sweet clover. When she finally gets accustomed to the sweet clover, she eats it well and responds in production.

Feeds which are less palatable may be fed in small quantities in conjunction with other feeds which are more palatable. The common farm grains, especially corn and oats, are palatable, as are also most pasture crops. Early cut, well made hays are far more palatable than late cut hays and common straws.

Digestibility.—The digestibility of feeds varies widely because of the variation in fiber content. Roughages are relatively high in fiber and low in digestibility. Early cut, well made, leafy hays are lower in fiber and higher in digestibility than late cut, poorly made hay, or straw.

Most grains and factory by-products are relatively low in fiber and high in digestibility. Grains, however, vary in their fiber content and digestibility. Oats, for example, carrying about 10 per cent of fiber, contain only about 70 per cent of total digestible nutrients. Corn, which

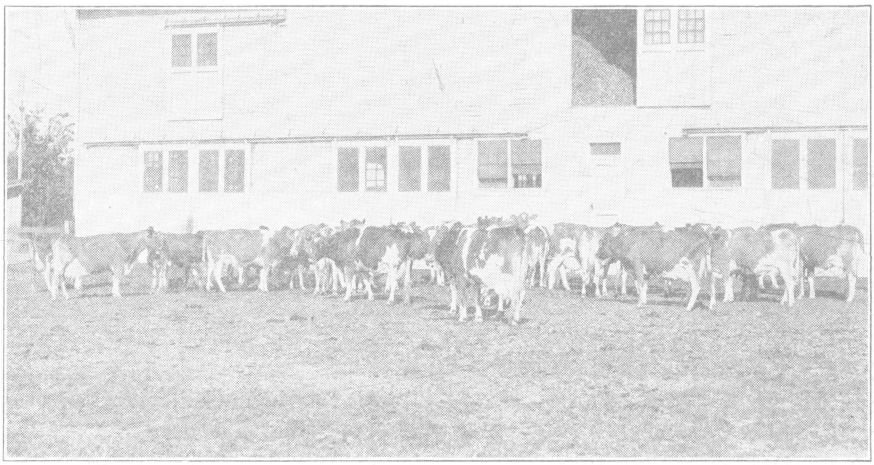

Fig. 2.—This herd of purebred Guernseys and Holsteins is a result of many years of constructive breeding and intelligent feeding. The owner was one of the first growers of alfalfa in central Ohio. He has been a member of a dairy herd improvement association since 1915. This herd produced an average of 8264 pounds of milk and 343 pounds of butterfat in the year 1941-42.

carries only 2 per cent of fiber, contains over 80 per cent of total digestible nutrients. In selecting feeds, digestibility must be kept in mind.

Bulk.—It has been often recommended that cows be fed light, bulky, grain rations. Apparently this recommendation was based on the fact that the cow has a large stomach capacity and her natural feed (pasture grass) is bulky. It was also thought that heavy concentrated feeds would be "balled" up in the process of mastication, and would not be penetrated by the digestive juices and thus not thoroughly digested.

Investigations at Michigan Agricultural Experiment Station clearly show that the violent churning process which goes on in the first two stomach compartments effectively breaks down the balls of feed (boli) and mixes them with the rest of the stomach contents. Investigations at

the Ohio Experiment Station tend to verify the Michigan findings. When cows are receiving large amounts of concentrates, there may be some advantage in using some of the lighter feeds in the mixture. There is no evidence that it pays to mix ground roughage with grain to make the ration light and bulky.

Variety.—Cattle, like other animals, may get tired of a restricted diet. Investigations at the National Research Center, Beltsville, Maryland, show that cows ate more hay and produced more milk when they were fed good quality timothy hay along with good alfalfa hay. The cows ate more hay and gave more milk when they were fed both kinds of hay than when they were fed only one kind of hay.

Corn and other common feed grains are so palatable that it is not necessary to feed a variety of grains to insure good consumption.

In feeding some classes of livestock, it is necessary to feed a variety of grains and concentrates to insure the presence of all the essential amino acids (protein builders). In the case of cattle, this is not necessary, as good roughage contains good quality proteins (proteins carrying the essential amino acids), and micro-organisms in the rumen, previously referred to, build up high quality proteins from low quality proteins and even from simpler substitutes carrying nitrogen.

Balance of Nutrients.—Balance of nutrients refers to the proper proportion of proteins, carbohydrates, and fats in the ration. It is necessary to furnish these nutrients in the proportion in which the cow uses them, because each type of nutrient performs its particular function most economically. Protein is necessary for the growth of hair, hide, hoof, bone, and muscle tissue, and to make the proteins of milk. It can be used to furnish heat and energy to the body but is too expensive and this is not an efficient use to make of it, since carbohydrates and fats are more plentiful and so can furnish heat and energy more economically. Carbohydrates and fats, on the other hand, cannot be used to build the necessary body and milk proteins.

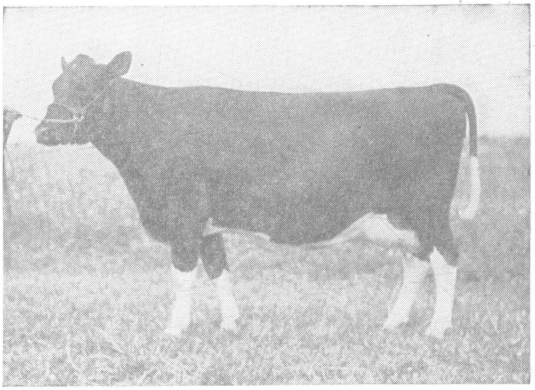

Fig. 3.—Good fitting pays. "Tritomia" properly fitted for her second freshening. This good show heifer produced 480 pounds of butterfat in her first lactation.

Completeness.—Not only should rations be balanced with regard to proteins, carbohydrates, and fats, but they must contain the necessary vitamins and mineral matter. In other words, a satisfactory ration must contain everything which the animal needs to carry on its normal functions.

Economy.—The economy of the ration, though named last, is certainly as important as any of the characteristics of a desirable ration. Economy is not secured, necessarily, by using low priced feeds or home grown feeds, exclusively. It is secured, rather, by growing at home the best roughages possible, and by producing such grain as is adapted to the farm; and then purchasing, when necessary, to balance the home grown grains, feeds which furnish the largest amount of nutrients for a dollar expended.

COMMON DAIRY FEEDS

Dry Roughages

The foundation of economical feeding is good quality roughage. The most desirable hay comes from the legumes and grass mixtures. Therefore, it is good business for dairy farmers to prepare their lands to grow legumes, especially clover and alfalfa. This may require some cash outlay, but it is not only good dairy husbandry to grow these feeds, it is equally good agriculture, as it results in soil improvement as well as more economical feeding.

Legume hays carry two or three times as much digestible protein as non-legume hays. The large amount of protein furnished by them makes it possible to use relatively low protein grain mixtures. This makes a direct saving, as protein feeds usually have to be purchased and usually cost more than carbonaceous feeds such as corn, oats, and other home-grown grains.

Another important factor about legumes is that they are high in lime. Legumes may carry five or six times as much lime as timothy and over twice as much as corn stover.

Alfalfa.—No single plant surpasses alfalfa as a hay crop where conditions are favorable for growth. It makes an excellent hay and outyields other legumes. Under optimum conditions it will produce heavily for at least four years. It has more soil improvement value than the common clovers and provides a ready modification of the rotation. It is also the most drouth-resisting crop we have. Alfalfa hay, to be of best quality, must retain a maximum of leaves and green color. The leaves contain twice as much protein as the stems, and are also richer in lime and phosphorus. Green hay is higher in vitamins than bleached hay. It is necessary, therefore, to cut each crop in good season and get it into the barn with a minimum of exposure.

Most farms in Ohio produce alfalfa satisfactorily after proper draining and a progressive system of liming and fertilization has been practiced.

The cutting of alfalfa should rarely start before blooming begins and should be well underway at the half-bloom stage and completed by full bloom. This rule is not fully satisfactory in Ohio, as partial failure

to bloom is frequent. It is better, therefore, to follow the recommended dates of cutting shown below:

TABLE II.—CUT ALFALFA BY THIS CALENDAR

Section of Ohio	First Cutting	Second Cutting	Third Cutting	Fourth Cutting
Southern third.....	May 28 to	June 28 to	Aug. 3-10	Sept. 8-15
1st and 2d "bottoms"	June 4	July 5		
Uplands.....	June 3-10	July 20-27	Sept. 3-15	
Middle third.....	June 7-14	July 20-27	Sept. 3-10	
Northwest	June 7-14	July 20-27	Sept. 1-7	
Northeast	June 10-15	July 20-27	Sept. 1-7	

The Agronomy Department recommends that alfalfa be allowed to wilt in the swath, then be raked into small windrows before it becomes brittle. The next morning the windrow should be rolled over as soon as the top of it has dried. Hay left in the swath too long will be discolored and may lose its leaves. Details on the making of alfalfa hay may be secured from Bulletin 160, "When and How in Haymaking," Agricultural Extension Service, Ohio State University.

Alfalfa Mixtures.—Alfalfa mixtures make an ideal hay for dairy cattle. Investigations referred to on page 8 show that cows prefer a mixture of alfalfa and timothy to straight alfalfa.

On many farms in eastern Ohio, alfalfa does not do well when grown alone, but grown in conjunction with clover and grass, it produces excellent crops year after year. On the Trumbull County Experiment Farm, alfalfa-clover-timothy the first year produced 6370 pounds of hay, and the second year, 8235 pounds. Clover mixed with grass produced only 4230 pounds. On some plots alfalfa-clover-timothy produced more than 5 tons per acre in a season.

On the Hamilton County Experiment Farm in southwestern Ohio, where alfalfa can be grown alone, the addition of timothy, in one test, increased the yield of hay practically a ton per acre.

Even on western Ohio dairy farms where alfalfa can be grown separately, alfalfa mixtures are preferable.

In 1930 (a drouth year) when first-year clover meadows at the Trumbull Farm made scarcely a ton of hay per acre, one plot of alfalfa-timothy yielded three times that much. In 1934 (another drouth year) the comparison was just as striking. First-year clover meadows with a good stand of plants were about as near a failure as they could be, but on 20 acres of established alfalfa-timothy meadow, the crop stood knee high on the first of June.

The feeding value of alfalfa and grass mixed hay is high. The mixture should be cut when the alfalfa is ready. The grass is immature then and highly digestible. The protein content of timothy grown with alfalfa may be 25 or 50 per cent higher than when it is grown alone.

In 1933, hay cut on June 7 contained 12.6 per cent crude protein. This hay contained 55 per cent of timothy and 45 per cent of alfalfa.

Second and third cuttings carry a much larger proportion of alfalfa and thus more protein.

In order to produce this valuable hay crop, it is necessary to lime as needed. Alfalfa seed should be inoculated under all conditions. Recommended seeding mixtures contain 3 to 7 pounds of alfalfa seed, depending on drainage and soil lime content, together with enough clover to make 10 pounds of legume seed. This is added to the usual grass seeding. It is common practice to sow 3 pounds of timothy seed with the fall grain and 6 pounds of timothy with spring grain. Brome grass is more valuable than timothy or orchard grass because it makes more growth in the summer. It should be seeded in the spring with alfalfa on soils with average or higher productivity.

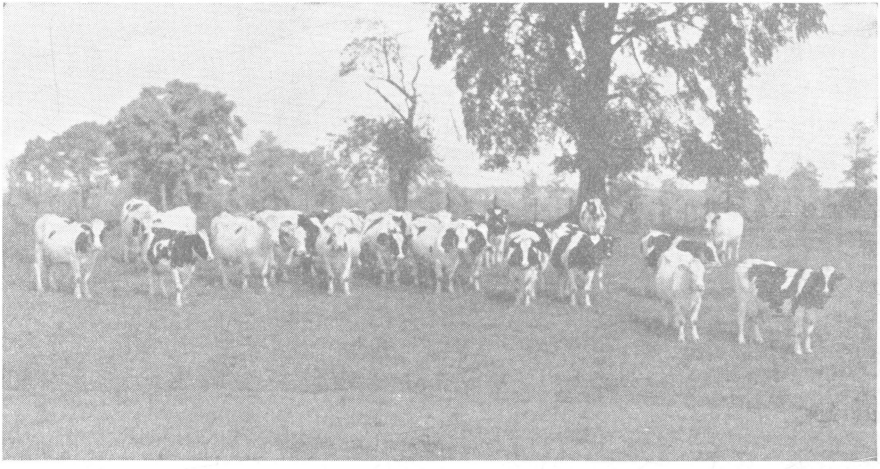

Fig. 4.—The Trumbull County Experiment Farm has clearly demonstrated that enormous crops of excellent quality alfalfa-timothy hay can be raised in northeastern Ohio when the soil is properly limed and fertilized. This Holstein herd on the farm proved the feeding value of good hay. This herd produced 10,368 pounds of milk and 353 pounds of butterfat in 1943-44.

Consult your county agent or the Agronomy Department of Ohio State University regarding seeding mixtures and methods of seeding.

In the southern part of the state, orchard grass may be added to the mixture. It should be borne in mind, however, that orchard grass matures earlier than timothy and is not a desirable feed for cattle if cut when mature.

Medium Red Clover.—This legume makes an excellent hay for dairy cattle. Investigations by C. J. Willard of the Ohio Agricultural Experiment Station show that red clover cut at the same time as alfalfa carries about 2 per cent less protein than alfalfa. It is necessary to retain as much of the leaves and green color as possible to get the most value from clover hay.

One of the most common errors in making clover is to cut it after the blossoms begin to turn brown. Such hay is coarse and stemmy, and

more likely to lose its leaves in the curing process. Investigations at the Ohio Experiment Station show that red clover produces nearly its maximum total yield at full bloom and its greatest yield of protein at about one-third bloom. In order to secure the largest amount of high quality hay, red clover alone or with grass should be all cut by the time of full bloom.

Alsike Clover.—This makes an excellent feed for dairy cattle. It may run slightly higher in protein than medium red clover and is somewhat finer. It is usually grown in mixtures with medium red clover. The blooming period is not as definite as that of red clover. If grown alone,

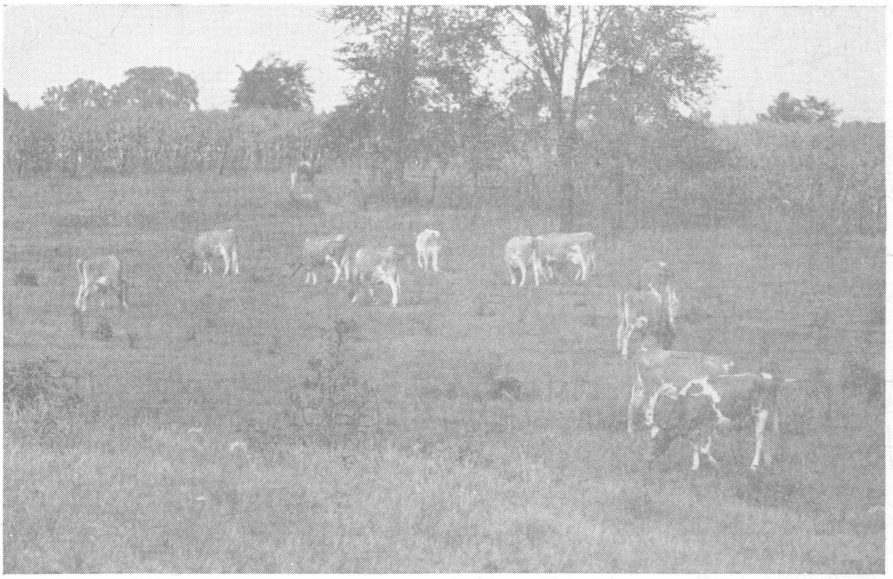

Fig. 5.—This herd of Guernseys often produces over 400 pounds of butterfat. Fertilized permanent pastures coupled with good quality hay makes possible large production at low cost. In 1942-43 the cows on test for the entire year produced an average of 7018 pounds of milk and 357 pounds of butterfat, and consumed only 1931 pounds of grain per cow. This herd has made a great record for low feed per pound of butterfat.

it should be cut at the same time as red clover or just after the red clover is cut. Alsike clover is better adapted to northern Ohio than to the southern part of the state.

Mammoth Red Clover.—This clover produces somewhat heavier yields than medium red clover. However, it is coarser and more stemmy and, therefore, may not be so desirable a dairy cattle feed as medium red or alsike clover. It comes into full bloom a week or ten days later than medium red clover. It should be cut like red clover, just before full bloom. It is a valuable feed.

Sweet Clover.—This crop contains about the same nutrient value as alfalfa. However, alfalfa is much to be preferred to sweet clover when it is possible to grow it, because it is a perennial and produces two or three crops a year.

Damaged sweet clover may reduce the clotting ability of the blood to such an extent that cattle bleed internally and ultimately die. Animals seriously affected by sweet clover poisoning will also bleed to death as a result of external cuts. Hay suspected of being toxic should be fed at alternate intervals with other roughage. The intervals of feeding sweet clover hay should not exceed 2 weeks.

Soybeans.—Soybeans make an especially valuable emergency hay crop, because they can be planted and harvested during the same season. Soybean hay is palatable, and carries about the same amount of protein and total digestible nutrients as alfalfa hay.

Soybean hay is not as economical as alfalfa, clover, or other rotation hay crops, because it is an annual crop and requires more labor to produce. Soybeans, when cut for hay, have no soil building value. Soybean hay, therefore, should not be substituted for rotation hay crops except in emergencies.

Soybeans differ from the other common hay crops in three respects: (1) The pods and seeds may account for as much as 25 to 40 per cent of the total weight of the hay; (2) the percentage of protein increases, rather than decreases, in the plant as a whole, from just after full bloom until the leaves start to drop; the high protein content of the seed accounts for this increase; (3) soybeans become more, rather than less, difficult to cure for hay as they advance in maturity. They should be harvested when the beans are forming in the pods but not later than the first of September, otherwise weather conditions may make drying difficult.

Grass Hay.—Timothy hay is not as valuable as hay made from the legumes. As it is usually made, it only carries about 3 per cent of digestible protein, which necessitates the feeding of high protein grain mixtures to balance the ration. Timothy hay is also low in lime, carrying from one-fifth to one-third as much as legumes.

The value of timothy hay can be increased, however, by early cutting. Experiments carried on at the Timothy Breeding Station in North Ridgeville, Lorain County, show that if timothy is cut just as it becomes fully headed, it produces 20 to 30 per cent more protein per acre than it does when cut just past full bloom. Timothy cut before bloom will not produce quite as many pounds per acre as when it is cut later, but the quality of the hay is enough better to offset the loss in production. Early cut timothy also has more color and is more palatable.

Oat Straw.—It has little to recommend it as a feed. There is no harm in allowing cattle to feed around a straw stack if they are also fed liberally with good quality hay and the necessary grain. Cattle sometimes crave a little coarse roughage when they are fed plenty of good hay.

Corn Stover.—Corn stover contains only about 2 per cent of protein and may contain less if badly weathered. If cows are being fed good hay and other feed morning and evening, it may be desirable to feed stover

in the middle of the day. Whatever is left may be used for bedding. Shredded stover makes good bedding, while uncut stover is a nuisance.

Pastures

Pasture is the natural feed for cattle. Good pasture is palatable, nutritious, and economical. Although pasture grass is usually classed as a roughage, it really is more like concentrates, being lower in fiber and higher in total digestible nutrients than other roughages on a dry matter basis.

At the National Agricultural Research Center, Beltsville, Maryland, Holstein cows consumed over 150 pounds of pasture grass a day, which furnished enough nutrients to maintain the body and produce 45 pounds

Fig. 6.—Fertilized bluegrass pasture on the Ohio State University farm. Good pasture is a palatable, nutritious and economical feed for dairy cattle. It has more of the qualities of concentrates than of roughage.

of milk, testing 3.5 per cent of fat. This is much more milk than such cows can produce on hay and silage alone. Other breeds respond in a similar manner.

Investigations indicate that the health and length of life of cattle is favorably affected by good pasture. Grass is not only rich in protein, carbohydrates, and fats, but it is also rich in vitamins, except Vitamin D. Milk produced by cows on good pasture may contain twice as much vitamin A as milk produced on winter feed. Milk produced on pasture will also be more yellow, due to the increase in carotene (one form of vitamin A).

Native Pastures (bluegrass).—Good native pastures contain a large percentage of bluegrass. On many farms, bluegrass pastures have received little care and fertilization and produce a small amount of feed for a short time only. Land that is adapted to permanent pasture and which should not be regularly cultivated may be so fertilized and managed as to be a valuable source of feed.

Agronomists suggest that the best sods be treated first. It is not necessary to fertilize the entire pasture at one time. If a few acres can be treated, the results may lead to further efforts. The soil to be improved should be tested to determine its lime requirements, and the necessary lime applied. After the lime requirement is satisfied, 400 to 500 pounds per acre of 20 per cent superphosphate or 0-14-7 fertilizer should be applied. Fertilizer should be applied every four or five years, and lime every eight or ten years. This treatment will induce the growth of white clover which will build up the nitrogen content of the land and encourage the growth of bluegrass.

By spreading manure on the pastures, some improvement can be made without the outlay of money. Experiment and experience show that treatment, where needed, increases the number of pasture days and the amount of feed produced.

In order to get the most out of bluegrass pastures, it is necessary to graze and clip them to keep the growth at from 1½ to 5 inches in height. The clover will be crowded out if the bluegrass is allowed to get too tall, and the bluegrass will suffer if the pasture is grazed continuously below 1½ inches.

Most pastures are not fenced for rotational grazing, so where continuous grazing is necessary, the number of cattle allowed to graze them should be varied according to the growth. Good bluegrass pastures have a place in the dairy feeding program. However, they are not to be relied on during dry weather. For that reason, good hay fields or emergency pastures are necessary for midsummer and dry periods.

Trash Mulch Seedings of Alfalfa Mixtures.—Alfalfa mixtures have been satisfactorily seeded on old hay and pasture fields without plowing. This method of seeding has provided good pasture and hay crops in a short time on farms where it is not feasible to use the rotated land for pasture.

The necessary lime should be applied first. The field is then thoroughly disked, preferably in the early spring, and 400 to 500 pounds of 0-14-7 fertilizer applied. The seed is then sown and covered lightly. The seeding must be protected from grazing just as meadows are usually protected.

This method of seeding is not adapted for use on land with good stands of grass. It is useful on unproductive hay and pasture fields. A seeding mixture of 10 pounds of alfalfa, 1 pound of ladino clover, and 6 pounds of timothy or orchard grass has proved satisfactory. Farmers with rolling land will do well to try this method of seeding as a means of increasing midsummer pasture.

Sweet Clover Pasture.—On many farms in western Ohio, this crop is used extensively. In eastern Ohio it is used relatively little. Second year sweet clover becomes relatively unproductive by midsummer. It may be grazed the first year but this decreases its second year production.

Alfalfa and Alfalfa-Grass Pastures.—Alfalfa alone and alfalfa mixtures make excellent pastures. However, alfalfa mixtures are preferred. Some farmers are securing most of their summer feed from these crops. The electric fence is an economical means of dividing meadows for grazing or protecting other crops from cattle. It has reduced the cost of fencing and thus made the grazing of meadows a more common practice (see Fig. 7).

The second crop of alfalfa makes an excellent pasture and is green when most other pasture crops are relatively unproductive. This crop may be grazed after it reaches a height of 8 to 12 inches. The cattle should be removed to permit re-growth after they have eaten down the

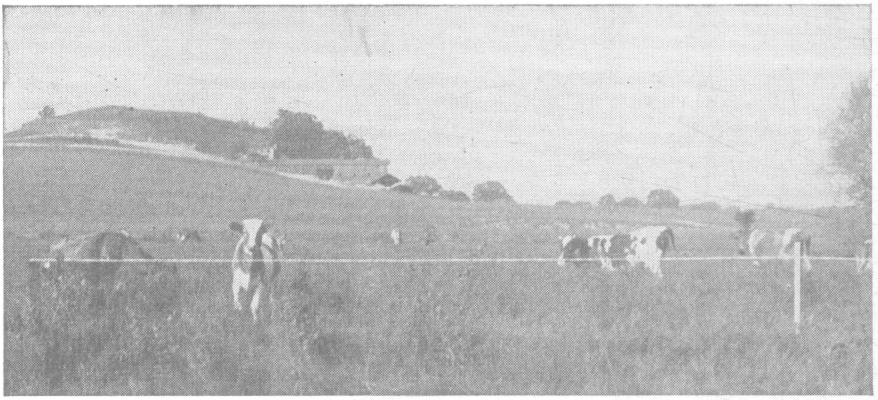

Fig. 7.—An electric fence is an economical means of dividing meadows for grazing. Animals soon learn to respect the charged wire, but are not afraid to graze close to it.

second growth. The third crop may also be grazed, but the cattle should be removed by September 10, if the field is to be kept for hay the following year. This is necessary so that the plants will have an opportunity to store up food in the roots for winter. Grazing may be continued as long as the weather is fit when the meadows are to be plowed.

On some level farms in Ohio, alfalfa mixtures make the most economical all season pasture crop. In order to avoid weakening the stand, the fields should be divided and grazed in rotation or grazed to maintain a stand at least 8 inches high.

Ladino Clover.—This large growing, white clover is proving to be a valuable addition to seeding mixtures where the crop is pastured part or all of the time. It is valuable for seeding, after disking, in unproductive permanent pastures which are being improved by lime and fertilizing. Seeding of ½ to 1 pound to the acre as part of a mixture is recommended.

Clover and Grass.—These meadows, cut in June, may furnish good pasture in the late summer or fall. Alfalfa and alfalfa mixtures, however, will furnish more feed and they are more dependable.

When cattle are on alfalfa and clover pastures, they may be subject to bloat. Some farmers pasture these crops and report no difficulty, while other report losses. It appears to be a good practice to fill cows before they are put on legume pasture the first time, and make salt, water, and hay available to them at all times.

Rye and Wheat.—Good stands of wheat and rye may be grazed in April. This is especially true if the growth is so rank that there is danger of lodging. If the field is soft, the cattle will damage the grain and new seeding.

Sudan Grass.—Sudan makes a good emergency pasture. It is a quick grower and withstands drouth better than most plants. If there is sufficient moisture in the soil to sprout the seed, it will usually make 15 to 18 inches of growth in 5 or 6 weeks. It is possible to sow it in early June and start pasturing it by the middle of July. Under favorable soil and weather conditions, it will carry two or more cows per acre.

Sudan grass is not as economical as good rotation pasture. Seed from May 25 to July 1. Prepare a good seedbed and cover lightly. Turn cows in when the grass is 15 to 18 inches high. Some dairymen run a fence through the field and graze each part alternately.

Sudan grass poisoning occurs in some areas. However, it is seldom reported in Ohio. Prussic acid is the poisonous principle which causes the difficulty. According to Bohstedt of the Wisconsin Experiment Station, dark green sudan grass is more likely to be high in prussic acid than is light colored grass. Sudan grass over 1½ feet high is relatively low in prussic acid and safe to pasture.

If cattle are not too hungry when they are turned on to sudan grass, they will usually stop eating before they get a fatal dose. Hence, it is a good practice to feed cattle well before allowing them to graze sudan grass and observe them for a stort time after they start feeding. If any of the cattle stop eating in 15 or 20 minutes, they should be removed.

Silage and Roots

The preservation of crops by means of the silo has several advantages. It is possible to put crops into the silo with little regard to the weather. The feed is stored with a minimum waste and a large amount of nutrients can be stored in a relatively small space. Good silage is a palatable feed and adds variety to the ration.

A study of dairy herd improvement association records made by the Bureau of Dairying, United States Department of Agriculture, showed that cows receiving silage produced a little more milk and fat than cows fed similarly but without silage. If a farmer has eight or more milking cows, he will find the silo profitable. The diameter of the silo should be such that at least 2 inches of silage may be fed a day. This will avoid unnecessary spoilage.

Corn Silage.—Corn silage is one of the most economical dairy feeds. This with good pasture and high quality hay make the very foundation of economical dairy feeding. Studies at the Ohio Station show that silage may be fed in large amounts without any bad effects on the cattle.

Satisfactory yields of good quality silage depend largely on the variety of corn used. Values of varieties of corn for silage are determined primarily by relative acre yields of dry matter (for this reflects the total digestible nutrients), and not by the yields of green material alone. Superior varieties of silage corn are, therefore, those that fully utilize the growing season (from normal planting to the normal date of silo filling). Such a variety may be expected to reach the dough to denting stage at least three years in five.

Some late maturing varieties may give higher yields of green material, but seldom do they give higher and often they give lower yields of dry matter than the ideal variety. The difference is, of course, water.

The stage of maturity of corn at silo filling controls the quality of silage. Silage from immature corn, high in moisture, or corn put in with too little moisture is not so palatable as silage from corn put in at about the time it is denting. If corn is too dry when put in, water should be added.

It requires more time and energy to cut corn finely. However, fine cutting will facilitate settling and increases the capacity of the silo. The first few loads may be cut into ⅜-inch lengths. Then cut the corn into ½-inch lengths until the silo is nearly full. Top off the silo with a few loads cut into ⅜-inch lengths. The fine silage on top may reduce spoilage.

Observations at the Ohio Experiment Station tend to show that corn which is well matured and dry may keep better if cut finely. On the other hand, corn which is green when cut may keep better if cut coarsely.

Corn Varieties.—Use adapted hybrids. Determination of the hybrid to grow will depend somewhat upon whether the corn is planted specifically for silage or primarily for grain (part being harvested for silage). On northern Ohio farms where some corn is grown for silage alone, U. S. 52, U. S. 13, and Ohio L. 94 are satisfactory. The most efficient silage producing varieties average 1 to 2 weeks later in maturity than varieties adapted for grain production.

Hay Crop Silage.—Alfalfa, clover, and soybeans make good silage when put in under proper conditions. It is a common practice to allow the feed to dry in the swath for two or three hours to reduce the water content to 60 or 70 per cent. The feed is then blown into the silo with a cutter. Although good silage is made without adding a preservative, a common practice is to add 40 to 80 pounds of molasses per ton or 100 pounds of finely ground corn meal or 150 pounds of corn and cob meal. Some farmers make excellent silage without preservatives. Corn and other preservatives are good insurance against spoilage. Hay crop silage with 150 pounds of corn and cob meal added to each ton of silage carries about 25 per cent of corn and cob meal on a dry basis. This adds much to its value.

Legume silage runs higher in protein than corn silage, but usually contains less total digestible nutrients because it is higher in moisture. It may be used to replace corn silage or fed along with it. Experiments indicate that it is better to feed dry hay along with silage and not depend on silage alone. Good hay crop silage can only be made when the crop is cut at the time it should be cut for making the best quality hay.

There are several advantages in putting hay crops in the silo. It is possible to harvest the crop when it is ready to cut with less regard to the weather. Loss in feed value resulting from allowing the crop to get too mature while waiting for good weather is often avoided by this method. There is less loss of nutrients in making hay crop silage than in making hay. This is especially true in unfavorable weather. A much larger proportion of the carotene (which becomes vitamin A) is pre-

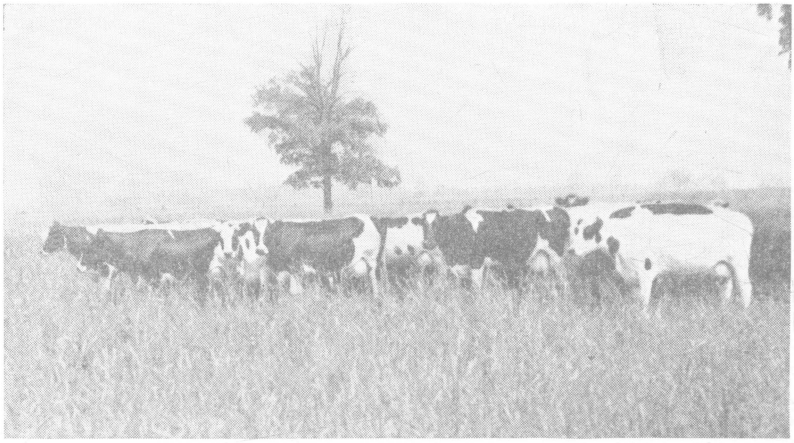

Fig. 8.—Legume hay and good pastures find a place in the ration of this herd of Holstein cows. It had an average production record of better than 400 pounds of butterfat for the past three years. The production per cow in 1942-43 was 13,019 pounds of milk and 449 pounds of butterfat.

served in hay crop silage than in hay made from the same crop. The carotene of hay crop silage helps maintain a high color in milk in the winter when pasture grass is not available. Grass crops and small grains are sometimes put into the silo. The grain crop should be put in during milk stage.

Roots.—Beets, mangels, turnips, and carrots are all excellent feeds, but the cost per pound of digestible nutrients is greater than silage. There is so much labor required to grow them that they are not likely to be commonly fed. Turnips should always be fed just after milking to avoid flavors in the milk.

Sugar Beet Tops.—These may be fed green or put into the silo. They are often laxative, so should be fed in limited amounts. If beet tops are plentiful and in good condition, feed as many as the cows handle without difficulty.

Corn.—Corn is the most abundant feed grain produced in the corn-belt. It is liked by all classes of livestock. It is usually the most economical source of carbohydrates and makes an excellent basis for concentrate rations for dairy cattle.

Some farmers are afraid of putting a large proportion of corn in the dairy ration. There is no basis for this fear, provided enough high protein feeds are fed to balance the ration. No common farm grain, for that matter, carries enough protein to balance the ration when only low-protein roughages are fed.

When good quality alfalfa hay or good pasture supplies a large proportion of the nutrients, corn may be used as the only concentrate, or it may be mixed with other homegrown grains. Corn, like all other farm grains, should be ground for feeding to all dairy cattle. Details on the preparation of grain and other feeds will be discussed later.

Corn and Cob Meal.—Most Ohio farmers grind the corn and cob together. This makes an excellent feed. The cob is low in digestible nutrients and, so, a pound of corn and cob meal is lower in feeding value than shelled corn. Some advantage is claimed for corn and cob meal because it is more bulky than corn alone. In the light of studies concerning the value of bulk in the dairy ration, it appears that bulk itself is of doubtful value except, perhaps, when large amounts of grain are fed. Probably, the most important reason for using corn and cob meal instead of ground shelled corn is that it is easier and quicker on many farms to grind the corn and cob together than it is to shell it first and then grind it. On farms where electric motors are used for grinding, it may be wise to shell the corn before grinding, because much less power is required to grind shelled corn than corn and cob and makes possible the use of a smaller motor.

Hominy.—Hominy is a by-product of hominy grits, which is manufactured for human consumption. It has about the same feeding value as cornmeal. Because it is kiln dried, it may be good economy to purchase hominy instead of cornmeal when the price is about the same as that of corn.

Barley.—Barley is excellent feed for dairy cattle. It carries a little more digestible protein and a little less of total digestible nutrients than corn. Investigations have shown that ground barley was equal to ground corn in feeding value when it formed 60 per cent of the grain ration. Barley may be substituted satisfactorily in whole or in part for corn when price or local supply warrants it.

Oats.—This grain is one of the very desirable feeds for dairy cattle. Oats are palatable and when ground or crushed, as they should be for dairy cattle, are bulky. Good oats are a little lower in feeding value than corn. Oats is the second most important feed grain crop in Ohio.

Wheat.—Wheat has approximately the same feeding value as corn in dairy cattle rations. In an experiment at the Ohio Experiment Sta-

tion, a ration carrying 40 per cent of corn was compared with one carrying 30 per cent wheat and 10 per cent corn. The cows on the wheat ration produced a little more milk and fat than the cows on the corn ration. However, the cows on the corn ration gained a little more in body weight. The butterfat tests of the cows when on the wheat ration, were a little higher than when they were on the corn ration.

Rye.—Rye, though not extensively fed to dairy cattle, is a satisfactory feed and worth about the same as corn. It is not considered to be as palatable as most other farm grains.

Wheat Bran.—Wheat bran is another of the very common dairy feeds. It is especially desirable for dairy cattle, because it is laxative and fairly rich in protein, and high in phosphorus. Bran, though slightly higher in protein than oats, carries a little less of total digestible nutrients.

Fig. 9.—The Breezy Hill herd of Jerseys enjoying good pasture. Average production in 1939-40: 8987 pounds of milk and 493 pounds of butterfat.

Wheat Middlings.—Wheat middlings are sometimes used in grain mixtures. Although higher in total digestible nutrients than wheat bran, they are probably not as palatable. This may be due to the fact that they are much more finely ground. Middlings, like bran, are good sources of phosphorus.

Beet Pulp.—Beet pulp is the residue left after the sugar is removed from sugar beets. It is a palatable feed and really should be classed among the concentrates. It is often soaked with water and fed to replace silage or give succulence to the ration. It carries about seven-eighths as much total digestible nutrients as corn, but is much lower in protein. It should be purchased on the basis of the nutrients it contains.

Molasses.—Both cane and beet molasses are good feeds for dairy cattle. Molasses has little protein. Its chief value is in the sugar that

it contains. The total digestible nutrients in molasses is less than 60 per cent.

Molasses is used in commercial feeds. It can be diluted and put with hay or grain. Due to the fact that molasses is difficult to handle and the fact that the cornbelt farmer usually grows his carbohydrate concentrates, he is not likely to purchase molasses unless it furnishes nutrients at a smaller cost than other common concentrates. As stated previously, molasses is a good preservative for hay crop silage.

Linseed Oil Meal.—Linseed oil meal is one of the most desirable feeds for dairy cattle. It is commonly used in the rations of milking cows as well as in the rations of calves and yearlings. Linseed oil meal is used extensively in fitting cattle for freshening and for showing. Many think it is laxative. However, investigations at the Michigan Experiment Station indicate that it is no more laxative than cottonseed meal. It is an excellent feed and it may well be used when the price of it is in line with other high protein feeds.

Cottonseed Meal.—Cottonseed meal is one of the most common high protein feeds used in dairy cattle rations. It is sometimes the cheapest source of protein for the ration and is a highly desirable concentrate. Many dairymen are prejudiced against cottonseed meal. It is variously criticized for being constipating and for causing abortion and general breeding difficulty. It is also thought to cause garget. Investigations indicate that these claims are unfounded.

The Oklahoma Station has fed cottonseed meal to heifers, from 30 days of age to maturity without producing ill effects when prairie hay was fed in conjunction with it. When beet pulp was substituted for hay, however, the cattle apparently suffered from a lack of vitamin A. It is known that hay carries vitamin A, while beet pulp does not. This experiment would indicate that cottonseed meal has doubtless been blamed for troubles really caused by vitamin A deficiencies. The amounts of cottonseed meal fed to heifers, and to pregnant and milking cows contained much in excess of the amount of protein needed to balance the poorest hays.

Investigations at North Carolina Experiment Station indicate that the other oil meals produce undesirable results when fed with poor roughages such as cottonseed hulls. When good roughages were fed, undesirable effects were not noted.

Apparently cottonseed meal can be used with safety up to 25 or 30 per cent of the ration, provided the cattle are once accustomed to it and a good roughage is fed.

Corn Gluten Meal.—This is a by-product of the manufacture of cornstarch and glucose. It is made up of the residue after most of the starch, glucose, and corn bran have been removed. It is a high protein feed, carrying about 35 per cent of digestible protein. It is a desirable high protein supplement. It is quite heavy, and is probably not as palatable as some of the other high protein feeds.

It may not be the best supplement when corn is the only grain fed and corn stover and silage are the chief roughages, since all the protein would then be derived from corn and no protein variety would be provided in the concentrates. However a variety of protein is not essential in the rations of dairy cattle.

Corn Gluten Feed.—This, like the meal, is a by-product of the manufacture of cornstarch and glucose. The gluten feed, however, contains the corn bran. It is much lighter than the meal and carries about 22 per cent of digestible protein. It makes an excellent addition to the ration when the price is in line with other high protein feeds. Like gluten meal, it adds no variety to the protein when heavy corn rations are fed.

Gluten meal and gluten feed should not be confused, as they are quite different in protein content.

Soybeans.—Ground soybeans make an excellent high protein feed for dairy cattle. Some studies indicate that the protein of soybeans is superior to that of other vegetable protein concentrates. Investigations show that soybeans have approximately the same feeding value as cottonseed meal and linseed oil meal.

Soybeans are grown extensively in Ohio. Many farmers in the western part of the state find that they are an economical source of homegrown protein. While beans are unpalatable to some classes of livestock, dairy cattle seem to relish them. Rations containing up to 25 per cent of ground soybeans do not affect the flavor of the milk or consistency of the butter. Larger proportions of beans produce a gummy butter. Soybeans may slightly increase the fat percentage of the milk. Soybeans, like grains, should be ground for dairy cattle.

Soybean Oil Meal.—This is the residue from the beans after the oil is extracted. It has a high feeding value comparable to good quality linseed oil meal and cottonseed meal. It is probably more palatable to dairy cattle than ground soybeans. The palatability of the feed, however, is affected by the amount of heat to which the beans are subjected while being processed.

Soybean oil meals are often referred to as "old process"—"expeller" or "solvent" process meal, according to the method used in extracting the oil. The old process involves the heating of the ground beans and then subjecting them to great pressure to extract the oil. In the expeller process, the beans are ground and heated, then passed through screw-type continuous presses called expellers. In the solvent process, the ground beans are treated with a fat solvent to remove the oil. The meal is then heated to remove the solvent and, according to a statement from one manufacturer, is heated sufficiently high to give the right flavor without browning the meal.

All of these meals are satisfactory feeds. The solvent process meal contains a little more protein and less fat than the expeller or old process meal. Soybean oil meal is extensively used, and is often the cheapest source of protein for concentrate rations.

Tankage (dry-rendered).—Tankage is not commonly fed in dairy cattle rations. It may be fed, however, as a protein supplement when the cost makes it an economical source of protein. One trial conducted by the Animal Husbandry Department of Ohio State University in cooperation with the Ohio Experiment Station showed that tankage made a satisfactory supplement when it composed 10 per cent of the ration. The ration containing the tankage was not as palatable as the regular herd ration, made up entirely of concentrates from vegetable sources.

Fish Meal and Kelp.—These products from the sea have been widely advertised as having unusual merit. In order to determine their value in dairy rations, the Ohio Experiment Station has carried on a number of experiments. In a long-time experiment, a ration composed of 400 pounds corn and cob meal, 300 pounds oats, 100 pounds bran, 100 pounds each of cottonseed meal and oil meal was compared with a similar ration in which 70 pounds of cottonseed meal was replaced with 50 pounds of

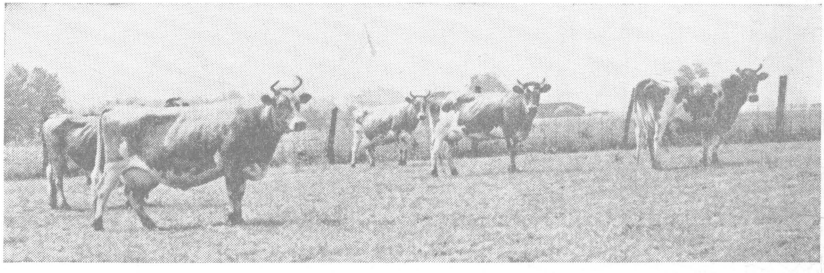

Fig. 10.—This herd of purebred Guernseys is the result of constructive breeding and intelligent feeding. The herd receives little other than home grown grains, legume hays, and pasture. Its average production in 1939-40 was 8461 pounds of milk and 466 pounds of butterfat. The herd has maintained an average of better than 400 pounds of butterfat for five years.

white fish meal and 20 pounds of kelp. The production of milk and fat was practically the same with both rations and the incidence of abnormal conditions remained about the same for both groups. In this experiment the fish meal and kelp appeared to be worth about as much as cottonseed meal.

Feeding experiments with Holstein calves reported by the Ohio Experiment Station showed that, in a dry-feeding system, a ration containing 12.5 per cent of white fish meal was of about the same value as rations which included 12½ per cent of dried skimmilk, blood flour, or day rendered tankage.

W. E. Peterson of the University of Minnesota found that cod liver oil fed to dairy cows may lower the test of milk. J. B. Brown and T. S. Sutton of Ohio State University found that menhaden fish oil gave similar results. In view of their findings, it may be well to use only limited amounts of fish meal in the ration and only those meals which are low in oil.

Fish meal should be bought on the basis of the nutrients it actually contains and not on the claims made for it.

Distillers' Grain.—The material left over from the grain used in the production of distilled liquors and alcohol is often dried and sold as distillers' dried grains. The value of this feed varies with the kind of grain used in the process. Distillers' dried grain from corn has a high feeding value, carrying a medium amount of protein. The distillers' grain from rye is much lower in feeding value, carrying about half as much protein as the corn distillers' grain, more fiber, and less fat. Like other feeds, care should be taken to purchase them on their analyses and not on their name alone.

Wet distillers' grains are sometimes available near the distilleries. This material should be bought on the basis of dry matter present, and the kind of grain used. The percentage of dry matter may be determined by drying and weighing a representative sample of the feed.

Brewers' Grains.—This is the material left from the barley used in the brewing of beer. It is dried sometimes and sold as dried grain; and sometimes is sold wet just as it comes from the vats. The brewers' dried grain is not nearly as valuable as distillers' dried grains from corn. It runs lower in protein and fat and higher in fiber than corn distillers' grain. The wet brewers' grains, like wet distillers' grains, should be bought on the basis of the dry matter present. Wet brewers' grain carries about 25 per cent as much dry matter as dried grain.

Proprietary Feeds

There are now a large number of ready mixed feeds on the market. Many of these are highly desirable. Others are of poor quality, containing large amounts of low value feedstuffs, usually high in fiber.

In purchasing feeds the dairyman should be guided by the analysis stated on the sack or tag. Feeds high in fiber and low in digestible nutrients are not worth as much as feeds low in fiber and high in digestible nutrients. Proprietary feeds should be purchased on the basis of what they contain and actually produce when fed rather than on the claims made for them.

If a dairy farmer is already producing corn and oats on his own farm, it is obviously unwise for him to buy ready mixed balanced rations and sell his homegrown grains. He should purchase the necessary high protein feeds to make a grain mixture that will be adapted to the kind of roughage he is feeding.

Before purchasing any mixed feed, it is good business to compare its cost with a simple mixture of homegrown grains and an economical high protein concentrate, carrying a similar amount of protein and total digestible nutrients, and feed the one which gives the most nutrients for the money.

High Protein Supplements.—A number of high protein supplementary mixtures have come on to the market. These usually carry about 32 per cent of crude protein and are designed to mix with homegrown feeds such as corn and oats, in proportions to make a concentrate ration

to balance the roughage fed. These mixtures are often desirable. They should be purchased only after comparing the costs with straight high protein concentrates.

Open Formula Feeds.—These are proprietary rations, the formulae of which are stated on the tags along with the guaranteed analyses. These feeds are not necessarily better or worse than closed formula proprietary rations. The open formula makes it possible for the buyer of feed to check the price of the feed with the prices of the individual ingredients and also to get a better idea of the palatability of the feed. The open formula idea has done much to take the mystery out of the commercial feed business and put it on a more scientific basis.

Minerals for Dairy Cattle

Cattle require more than a dozen mineral elements. These are essential for normal growth and development. These elements are also needed for the growth of the plants which the cow eats, and thus she may secure practically all she needs from the common feeds.

There is no evidence that complex mineral mixtures are necessary or desirable in the rations of dairy cattle. If certain minerals are not supplied in sufficient amounts those lacking should be added.

Salt.—Common salt (sodium chloride) should be a part of all rations. It is essential for normal growth and development. Salt may be added to the grain ration or placed where the cattle can get it at will. Adding salt to the grain ration increases its palatability. If the cattle are also allowed to take it at will, they will be sure to get the right amount. Hence, salt can best be supplied both ways.

Calcium (lime).—The animal body requires lime. It is essential to bone and tooth development, and plays an important part in reproduction. A large amount of it is also required in milk production. Milk contains more of this element than any other natural food.

Grains are relatively low in calcium. However, roughages and especially legumes carry large amounts of it. Cattle receiving plenty of good alfalfa, clover, soybean, or mixed hay, will get plenty of this element. When only non-legume hay is fed, the ration should be supplemented with calcium. The cheapest source of this element is ordinary limestone. This may be added as pulverized limestone at the rate of 2 pounds per 100 pounds of grain mixture. It may also be free-fed as part of a simple mineral mixture, suggested on next page.

Steamed bone meal is also a good source of calcium for cattle feeding. It is especially desirable when the ration lacks phosphorus as well as calcium, as it contains both of these elements.

Phosphorus.—Phosphorus, like calcium, plays an important part in bone and tooth formation and reproduction. Considerable amounts are given off in the milk. Loss of appetite is one of the first symptoms of a lack of this element in the ration. Cattle later develop an abnormal appetite and become emaciated.

Roughages are relatively low in phosphorus, but grains contain more of it. Certain factory by-products such as wheat bran, cottonseed meal, and linseed oil meal contain sufficient amounts of it to supply the requirements of the cow when they make up 20 per cent of the concentrate mixture, provided the concentrate ration is fed in reasonable amounts.

Cattle receiving only non-legume hay must be fed a high protein grain mixture if the ration is balanced. The above named feeds and others similar usually make up a large portion of such mixtures and hence the ration usually carries enough phosphorus. Cattle fed large amounts of good quality alfalfa or other legume hay need little besides homegrown grains to supplement the roughage. Under such conditions, the ration is often low in phosphorus and this element should be added. Cattle on good pasture receiving little or no grain may need a phosphorus supplement. Steamed bone meal is one of the best sources of this element. Spent bone-black and dicalcium phosphate may also be used. Rock phospate may only be used if it is defluorinated and does not carry more than 0.1 per cent of fluorine.

Iodine.—Ohio is located in what is sometimes called the goitre belt. This area is characterized by a lack of iodine in the soil and, hence, feeds are often lacking in this element. One of the most common symptoms of a lack of iodine is enlarged necks (goitre) in newborn calves. Where this condition is prevalent, iodine should be added to the ration. This may be supplied by a good commercial iodized salt, or it may be added as potassium iodide. One ounce of potassium iodide added to 300 pounds of feeding salt will supply all the iodine that is necessary. The potassium iodide may be satisfactorily added to salt by first mixing the potassium iodide with 8 to 10 pounds of salt and then scattering this over the remainder and mixing well by shoveling it over several times.

Mineral Mixtures.—Supplement the ration with only those minerals known to be lacking. In some cases, iodized salt alone may be sufficient. When more minerals are needed, one of the mixtures given below will meet the cow's requirements in Ohio. Add 3 pounds of one of these mixtures to each 100 pounds of grain or allow the cow to eat either at will.

(1) 200 lbs. bone meal
100 lbs. salt (iodized or plain)

(2) 100 lbs. bone meal
100 lbs. ground limestone
100 lbs. salt (iodized or plain)

Table VII on page 40 gives the calcium and phosphorus content of the common feeds. This information may be helpful in planning mineral supplements.

Stock Tonics

The best tonics for dairy cattle are good well balanced rations and regular care. If cattle are thrifty and free from disease they need no medicine. When they are sick or diseased they deserve the attention of a competent veterinarian who can prescribe the necessary treatment for the particular difficulty. In general, stock tonics and patent medicines are not recommended.

PREPARATION OF FEEDS

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GRAINS

Investigations show that it is economical to grind grain for dairy cattle. When the whole grain is fed, much of it will pass through undigested. Grain should be ground between coarse to medium fine. Cattle seem to prefer a granular feed to one that is flour-like, and actually produce more milk on medium ground grains. Grain should be ground fine enough to prevent its passage through the cow undigested.

If a hammer mill is used, shelled corn or corn-on-the-cob should be ground with a ½-inch screen, oats should be ground with 5/16-inch screen, and wheat may be ground with a ⅜-inch screen.

ROUGHAGE

During the past few years, there has been some agitation for the chopping or grinding of hay and other roughages. Some of this has been inspired by a desire to sell special machinery for this purpose. The results of a large number of experiments indicate that it does not pay to grind or chop good quality roughage. Forbes, at the Pennsylvania Station, found that ground alfalfa was slightly less digestible than the unground. Nevens, of the Illinois Station, found that the grinding of soybean and alfalfa hay did not increase milk production enough to cover the cost of grinding.

Weaver and Mathews of the Iowa Station found that ground hay was somewhat less palatable than whole hay. In three trials at the Wisconsin Experiment Station, chopped alfalfa hay was found to be a little less valuable than the same quality of the unchopped alfalfa. The difference, however, was so little that it can be said the chopping neither increased or decreased the value of the hay. In three trials at the same Station, involving cut and uncut soybean hay, it was found that cows refused from 14 to 19 per cent more of the uncut hay than the cut hay. The cutting added nothing to the value of the hay beyond causing the cows to eat it with less waste.

There may be some advantage, under certain conditions, in running hay through a cutter when putting it into the barn. This method makes it possible to store twice as much hay in the same space, and it may facilitate its feeding. If this practice is followed, the farmer should make sure that his mows can stand the extra load. It is also necessary to dry the hay more thoroughly if it is cut into the mow. A moisture content of 25 to 30 per cent may be safe for long hay, while cut hay should not carry over 22 per cent of moisture. The idea that cutting hay into the mow, so moist that it will brown, adds value to it, is erroneous. If browning takes place, something is lost, not added.

Pre-digesting Feeds

Good feeders are always interested in methods of making feed more valuable. From time to time, various processes have been advocated. One process recommended by certain promoters was to cut or grind the roughage and add a starter and warm water or steam, allowing the mass to ferment in a vat. The claim was made that this would break down the crude fiber and change the carbohydrates to reducing sugars, thus increasing the digestibility of the feed. The final product was called sugar jack. This process was supposed to make roughage almost equal to grains in feeding value.

Professor Hayden and associates at the Ohio Experiment Station made extensive studies to determine the value of the schemes being advocated for pre-digesting feed. Samples of feed before and after processing were taken from various farms. These samples were analyzed for crude fiber and reducing sugars. It was found that there was little or no change in the fiber and sugar content caused by processing.

The converters studied were made up chiefly of malted grains and depended on diastase to convert carbohydrates to sugar. Diastase will convert raw starch slowly and will act rapidly on cooked starch. Diastase did not produce invert sugars in processed roughage because the roughage processed contained no free starch. The carbohydrate of roughage is made up chiefly of cellulose. These investigators found that by processing a mixture of grain and roughage with sugar jack converter they were able to develop invert sugar to the extent of 10 per cent of the dry matter. However, this conversion of starch to sugar did not add definitely to the value of the feed. Rats fed hay and grain processed with and without converter grew slightly faster on the feed containing no converter.

The value of feed processed by the so-called *Kultograss* system was compared with feed processed with an equal amount of corn and oats, taking the place of the converter. The roughage used was alfalfa hay and corn stover. This trial showed that the "Kultograss" feed was no more valuable than that processed with corn and oats.

Both types of processed feed were also compared with a normal ration of hay, silage, and grain, fed according to production. The milk production was practically the same for both systems of feeding, but butterfat production was 7.5 to 11 per cent higher on the normal ration. The live weights of cattle fed on the two systems slightly favored the processed feed. However, this difference was probably not significant.

The Central Experimental Farm of Canada studied the processing of feeds for dairy cattle. The following is a quotation from Bulletin No. 96 of the Dominion of Canada Department of Agriculture:

1. In neither trial did the "processing" of the material add to or improve the nutritive value of the original roughage as judged by the results of the practical feeding tests, and by the chemical and bacteriological analyses.

2. In the preliminary feeding trial, the silage ration produced 8.9 per cent more milk and 6.2 per cent more fat than the sugar jack ration. In addition, the sugar jack ration was found to be more expensive than the silage ration. In the second

feeding trial, the silage ration produced 1.8 per cent more milk and 11.7 per cent more fat than the ration containing sugar jack. The production of milk and fat from the consumption of the unprocessed feed, dry roughage, was equal to that from the roughage of the same character processed by the sugar jack system.

It is evident from the experiments referred to that the pre-digestion of feeds does not increase production and thus is an unnecessary expense.

Mixing Chopped or Ground Roughage with Grain

It has been suggested that grain mixed with chopped or ground roughage would be more thoroughly digested because it would then remain in the paunch longer. Investigations show that cows mix the roughage and grain together in the paunch without assistance.

C. C. Hayden and associates at the Ohio Station found that mixing grain and roughage did not increase the value of the ration. In fact, it required more hay and grain to produce a given amount of milk when the grain was mixed with the roughage. The ground hay proved to be less palatable than the unground.

A serious disadvantage in mixing rations composed of ground hay and grain is that the cows receiving the most hay also receive the most grain. It will be seen later that this is not always desirable.

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HOW TO FEED MILKING COWS

When Not on Pasture

It is impossible to lay down hard and fast rules of feeding which will meet the conditions on all farms. There are, however, a number of simple rules which make for a more economical and efficient use of feed. The kind and quality of hay and other roughage, as well as the kind of grain produced will determine in large measure the method of feeding and the kind of rations fed.

Feed Good Quality Hay Liberally.—When plenty of good quality legume or mixed hay is available, feed the cows all the hay they will eat at least twice daily. Feed enough hay so that some is left uneaten in the manger. Where cows are put in stanchions only for milking and are allowed to run in covered yards the rest of the time, it is a good practice to keep good hay before them at all times.

When only a small amount of good hay and plenty of ordinary hay is available, cows will produce better over a long period of time if they are fed a little good hay along with the poorer hay than if they are fed the good hay exclusively until it is gone and then be compelled to rely entirely on the poorer hay. Certainly it will pay to give the cows in high production some good quality hay if it is available.

Cows receiving all the good quality hay they will eat get most of the protein they require from this source. This system of feeding makes it possible to use practically nothing but homegrown grains in the concentrate ration.

When milk production declines, the amount of grain and hay may be decreased and the silage increased. The amount of grain required, by this system, for cows in medium production is less than was formerly recommended. Under this plan of feeding, a cow can make a large proportion of her milk from roughage. She may also remain in better physical condition than when crowded with grain.

It is not necessary or desirable to weigh each feed of hay and silage in order to feed accurately. The amount of silage fed can be readily estimated by feeding with a receptacle of known capacity. The amounts of hay fed may be estimated or weighed occasionally when calculating rations.

Limit the Amount of Corn Silage Fed.—This rule applies especially to cows in high production. Feed Brown Swiss and Holsteins 20 to 25 pounds of corn silage daily and feed Ayrshires, Guernseys, and Jerseys 15 to 20 pounds daily. It is not necessary to weigh out exact amounts. The amount fed can readily be estimated with a shovel or basket. This practice will result in a larger consumption of hay. The reason for this recommendation is not that corn silage is an inferior feed. It is an excellent feed, palatable and nutritious, but it is relatively low in protein while good legume or mixed hay is relatively high in protein. Good silage carries about 1.3 per cent of digestible protein, while good legume and mixed hay will vary from 7 to 10 per cent of digestible protein.

Large cows receiving limited amounts of silage will eat from 25 to 40 pounds of good hay daily, but may eat less than half that amount if allowed all the silage they will eat. Cows eating large amounts of hay will secure most of the protein they need from hay and will, therefore, not require as much high protein feed in the grain mixture. Since protein concentrates are usually the most expensive feeds and are often purchased, it is desirable to secure as much protein as possible from homegrown roughage.

When only *low quality or grass hay* is available, it is not necessary to restrict silage feeding, since non-legume hay and corn silage carry about the same proportions of protein and total digestible nutrients. The amount of hay and silage fed under these circumstances may well depend on the amount of these feeds available.

Feed *hay crop silage* in conjunction with dry hay. Experiments indicate that cows like some hay along with the hay crop silage. Usually the amount of hay crop silage fed should be limited to about 30 pounds daily. The object in dairy cattle feeding is to get a maximum of good roughage or forage into the cows as this type of feed is the cheapest source of nutrients.

Corn Stover.—Cows fed good quality legume hay often crave some coarse roughage such as straw or corn stover. There is no objection to offering cattle such feed after the cows receive all the good forage they will eat. It is a common practice to give cows liberal quantities of stover once a day to pick over. The cattle will pick out the finer, more palatable portions and leave the coarser parts.

Amount of Grain to Feed When Not on Pasture

Feed grain according to production. One of the most common errors in dairy cattle feeding is to give the same amount of grain to each cow. It is not necessary actually to weigh each feed of grain. If the grain measure is checked with scales to see how much it holds, the feeder can estimate the amount of grain fed to each animal with sufficient accuracy. It is a common practice among dairymen to feed Guernseys and Jerseys 1 pound of grain for each 3 or 4 pounds of milk produced and feed Ayrshires, Brown Swiss, and Holsteins 1 pound of grain for each 4 or 5 pounds of milk produced.

Where an abundance of good roughage is fed, cows receive enough nutrients from this source to maintain their bodies and produce considerable quantities of milk. For example, a Holstein cow weighing 1400 pounds which eats 25 pounds of good alfalfa-mixed hay and 25 pounds of silage receives enough protein and total digestible nutrients to maintain her body and produce about 20 pounds of milk containing 3.5 per cent butterfat. A Jersey cow weighing 1000 pounds eating 20 pounds of alfalfa-mixed hay and 15 pounds of corn silage receives sufficient nutrients to maintain her body and produce about 15 pounds of milk containing 5 per cent of butterfat.

In view of these facts, a more accurate rule is to allow little or no grain for Guernseys and Jerseys giving less than 15 pounds of milk daily and little or no grain for Ayrshires, Brown Swiss, and Holsteins giving less than 20 pounds of milk. Then feed Guernseys and Jerseys 1 pound of grain for each 2½ pounds of milk over 15 pounds produced daily and feed Ayrshires, Brown Swiss, and Holsteins 1 pound of grain for each 3 pounds of milk above 20 pounds given daily.

The higher testing breeds require a little more grain per pound of milk because it takes more feed to make the higher testing milk. According to the above rule, a Jersey giving 40 pounds of milk would receive 10 pounds of grain daily, while a Holstein cow giving 50 pounds of milk would receive 10 pounds of grain.

It must be kept in mind that these recommendations only hold when an abundance of good hay is fed.

When Cattle Are on Pasture

Cows will consume enough grass when on pasture to produce large amounts of milk and butterfat without any concentrates. However, high producing cows cannot eat enough grass to make their maximum flow of milk and, so, pastures should be supplemented with concentrates when necessary. Experiments referred to earlier show that Holstein cows may consume up to 150 pounds of good pasture grass in a day, which would furnish enough total nutrients to produce about 45 pounds of 3.5 per cent milk. It is safe to assume that a Holstein cow will eat enough pasture, if it is of good quality, to make 35 pounds of milk daily and a Jersey cow 20 pounds without a grain supplement.

As the season advances, permanent pastures become less productive until they do not furnish enough feed to maintain even a dry cow. The most unproductive season is likely to occur between July 1 and September 1. After that time, fall rains improve pastures.

As suggested earlier, good meadows, especially those containing alfalfa mixtures and pastures of sudan grass, may furnish good grazing in midsummer. Regardless of the kind of pasture available, cows should be fed hay or other supplementary roughage whenever they will eat it. High producing cows should receive grain even on good pasture.

Guernseys and Jerseys on luxuriant pasture should receive 1 pound of grain for each 2½ pounds of milk above 20 pounds. Ayrshires, Brown Swiss, and Holsteins should receive 1 pound of grain for each 3 pounds of milk produced above 30 pounds.

Fig. 11.—This herd of Holsteins made an average of 12,568 pounds of milk and 457 pounds of butterfat in 1942-43, and was the highest producing "small" herd in Ohio dairy herd improvement associations that year. Alfalfa hay and alfalfa pasture are the bases of the feed.

Grain Rations.—There is no one best combination of grains and concentrates. A satisfactory ration may become uneconomical due to supply and price changes. The wise dairyman will vary his ration occasionally to take advantage of these fluctuations. To insist on a particular ration, regardless of price, is uneconomical.

Grain rations should be mixed in quantity and should contain enough protein to balance the roughage fed. Some farmers endeavor to feed each cow by giving her a certain amount of each concentrate. It is easier to mix up several hundred pounds of grain and concentrates and then feed the proper amount of the mixture to each cow.

There is a tendency to over-estimate the quality of roughage. It is safer to under-estimate its quality and use a little extra protein. However, there is no advantage in overfeeding on protein. As will be illustrated, any farmer can check a ration by means of a feeding standard.

The Morrison Standard commonly used in this country shows how much protein and total digestible nutrients are required to maintain a cow of a certain size, and also shows how much protein and total digestible nutrients are required for a pound of milk of various tests. Thus by multiplying the requirements for one pound of milk by the number of pounds of milk produced, the milk requirements are determined. This, added to maintenance requirements, gives the total requirement.

Suggested Rations for Milking Cows

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A cow's stomach may hold 60 or more gallons. It is so formed that a cow is able to digest large amounts of bulky feed such as hay, pasture grass, and silage. Furthermore, it is more economical to feed cows all the roughage they will eat and then supplement that roughage with a suitable grain ration.

The following combinations are suggested rations. The analysis, the price, and the availability of feedstuffs should always be considered in making up rations. Also, the grain ration should be based on the available homegrown roughage.

If large amounts of silage and limited amounts of legume or mixed hay are fed, the grain mixture should contain 2 or 3 per cent more protein than indicated in the mixtures adapted to that roughage.

When pastures are limited and have to be supplemented with large amounts of hay or silage, the grain ration should be adapted to supplementary roughage.

There is no best grain ration. All of the common farm grains: corn, oats, wheat, barley, rye, and buckwheat may be fed. Use grains and concentrates in proportion to their availability or cost. Vary the proportion of grains in the above rations to meet your own situation.

The most important fact to keep in mind in planning grain rations is to provide enough protein to balance the ration and still not use more than is necessary.

Simple grain rations are just as satisfactory as complicated rations. Monroe and Krauss of the Ohio Experiment Station compared a complicated ration (A) with a simple ration (B) given below. The cows receiving the simple ration produced as much milk and fat as the cows did on the complex ration. In one case the cows received mixed hay and silage and in the other case the cows were on pasture.

RATION A	RATION B
800 lbs. ground corn	1550 lbs. cornmeal
400 lbs. ground oats	400 lbs. soybean oil meal
300 lbs. wheat bran	20 lbs. bone meal
200 lbs. molasses mixed feed	10 lbs. limestone
100 lbs. linseed oil meal	20 lbs. salt
150 lbs. soybean oil meal	
20 lbs. bone meal	
10 lbs. limestone	
20 lbs. salt	

These results are in keeping with the results obtained by other Experiment Stations.

RATIONS

	Per cent of total protein in ration
1. With plenty of good pasture, feed:	
a) 700 lbs. corn or corn-and-cob meal 300 lbs. oats	9.3
b) 600 lbs. corn or corn-and-cob meal 200 lbs. oats 200 lbs. wheat bran	10.5
2. With good quality of alfalfa, clover, or mixed hay with not less than 50 per cent of legume in the mixed hay, feed:	
a) 600 lbs. corn or corn-and-cob meal 300 lbs. oats 100 lbs. soybeans	12.2
b) 500 lbs. corn or corn-and-cob meal 300 lbs. oats 100 lbs. wheat or barley 100 lbs. soybean, linseed, or cottonseed oil meal	13.2
3. With good quality mixed clover and timothy, with 25 to 50 per cent legume, feed:	
a) 500 lbs. corn or corn-and-cob meal 200 lbs. oats 100 lbs. wheat 200 lbs. linseed oil meal	14.8
b) 600 lbs. corn or corn-and-cob meal 100 lbs. oats 100 lbs. buckwheat 200 lbs. soybean or cottonseed oil meal	16.1
4. With excellent quality grass hay with a light mixture of legumes, feed:	
a) 500 lbs. corn or corn-and-cob meal 100 lbs. oats 200 lbs. wheat bran 200 lbs. corn gluten meal	16.8
b) 300 lbs. corn or corn-and-cob meal 400 lbs. oats 300 lbs. linseed meal	17.8
5. With timothy hay, stover, or straw, feed:	
a) 600 lbs. corn or corn-and-cob meal 100 lbs. oats 100 lbs. wheat 300 lbs. cottonseed or linseed oil meal	18.1
b) 600 lbs. corn or corn-and-cob meal 200 lbs. oats 300 lbs. soybean oil meal	18.6

FEEDING STANDARDS

It is impossible to reduce the feeding of cattle to mathematics. There is always an opportunity to exercise judgment. The feeding standard, however, shows the need of balanced rations and is an excellent guide in determining the kinds and amounts of feed to give.

To apply the Morrison standard: (1) Determine the weight of the cow under consideration. (2) Note the maintenance requirement in terms of digestible protein and total digestible nutrients as given in Table V. (3) Multiply the digestible protein and total digestible nutrients required to make a pound of milk of the kind produced, by the number of pounds of milk given daily. (4) Total the maintenance and milk requirements. (5) Then determine the amounts of digestible protein and total digestible nutrients in the pounds of feeds in the proposed ration.

If the feed furnishes the amounts of nutrients called for, the ration may be considered balanced. If too much or too little protein is furnished the protein content of the grain ration may be adjusted to furnish the proper amount. If not enough total digestible nutrients are furnished the amount of feed should be increased.

Illustration of Use of Feeding Standard

Computing ration for 1200-pound cow giving 40 pounds of 4% milk:

	Digestible crude protein	Total digestible nutrients
For maintenance of 1200-pound cow	.762	9.29
For production of 40 pounds of 4% milk	1.960	12.96
Total	2.722	22.25

Give amounts of feed in accordance with suggestions made.

	Nutrients Furnished by Each Feed†	
	Digestible crude protein	Total digestible nutrients
30 lbs. corn silage	.390	5.610
20 lbs. clover and timothy mixed	.960	10.280
9 lbs. grain (nutrients in concentrate computed below)	1.233	6.876
Total	2.583	22.766

These figures are close enough to satisfy the standard.

Method of determining nutrients furnished by concentrate mixture:

Concentrate mixture	Nutrients in Feeds in Grain† Digestible crude protein	Total digestible nutrients
500 lbs. corn-and-cob meal	30.0	379.5
200 lbs. ground oats	18.8	143.0
200 lbs. soybean oil meal	75.2	165.6
900 lbs. Totals	124.0	688.1
Nutrients per 100 lbs. of mixture	13.7	76.4
Nutrients per pound of mixture	.137	.764
Nutrients in 9 pounds of mixture	1.233	6.876

† See Table of Digestible Nutrients, page 38.

TABLE V.—MORRISON FEEDING STANDARDS FOR DAIRY COWS (Adapted)*

	DIGESTIBLE PROTEIN Recommended for good cows under usual conditions	TOTAL DIGESTIBLE NUTRIENTS Recommended for good cows under usual conditions
A. FOR MAINTENANCE (per head daily)	Lbs.	Lbs.
700-lb. cow	0.476	5.81
750-lb. cow	0.506	6.18
800-lb. cow	0.536	6.53
850-lb. cow	0.564	6.88
900-lb. cow	0.593	7.23
950-lb. cow	0.621	7.58
1,000 lb. cow	0.650	7.93
1,050-lb. cow	0.678	8.27
1,100-lb. cow	0.706	8.61
1,150-lb. cow	0.734	8.95
1,200-lb. cow	0.762	9.29
1,250-lb. cow	0.790	9.64
1,300-lb. cow	0.817	9.97
1,350-lb. cow	0.844	10.29
1,400-lb. cow	0.872	10.63
1,450-lb. cow	0.898	10.96
1,500-lb. cow	0.925	11.28
1,550-lb. cow	0.952	11.61
1,600-lb. cow	0.979	11.94
1,650-lb. cow	1.005	12.26
1,700-lb. cow	1.032	12.58
1,750-lb. cow	1.058	12.90
1,800-lb. cow	1.084	13.23
B. FOR MILK PRODUCTION PER POUND OF MILK (to be added to allowance for maintenance)		
For 3.5% milk	0.046	.300
For 4.0% milk	0.049	.324
For 4.5% milk	0.052	.349
For 5.0% milk	0.056	.373
For 5.5% milk	0.059	.397
For 6.0% milk	0.062	.422
For 6.5% milk	0.065	.446

* Taken with the permission of The Morrison Publishing Company, from Feeds and Feeding, Twentieth Edition, by F. B. Morrison.

TABLE VI.—AVERAGE COMPOSITION AND DIGESTIBLE NUTRIENTS*

FEEDING STUFF	Total dry matter	Dig. protein	Total dig. nutrients	AVERAGE TOTAL COMPOSITION				
				Protein	Fat	Fiber	N-free extract	Mineral matter
Dry Roughages								
Alfalfa hay, before bloom	90 4	14.2	53.2	19.0	2.7	22.3	36.6	9.8
Alfalfa hay, 1/10 to ½ bloom	90.6	11.0	50.1	14.9	1.7	30.1	35.0	8.9
Alfalfa hay, ¾ to full bloom	90.4	9.9	49.7	14.0	2.0	30.3	35.8	8.3
Alfalfa and timothy hay	92.4	6.8	50.2	11.6	1.4	32.2	41.8	5.4
Barley hay	91.9	4.9	54.1	7.5	2.0	26.6	49.0	6.8
Clover hay, alsike, in bloom	89.0	8.6	52.7	13.4	3.2	26.9	37.7	7.8
Clover hay, mammoth red	88.0	6.9	51.7	11.7	3.4	29.2	37.0	6.7
Clover hay, medium red, before bloom	89.6	12.0	56.4	18.7	3.6	18.3	41.8	7.2
Clover hay, medium red, in bloom	88.2	7.8	53.4	12.6	3 6	26.2	39.6	6.2
Clover hay, medium red, past full bloom	88 2	7.3	51.7	12.3	3.6	28.1	36.8	7.4
Clover hay, sweet, first year	93.3	14.6	53.5	19.5	2.9	21.0	41.2	8.7
Clover hay, sweet, second year	92.0	10.5	49.9	14.0	2.0	29.8	38.7	7.5
Clover and timothy hay, 30 to 50% clover	91.9	4.8	51.4	9.2	2.2	31.9	43.6	5.0
Corn stover (medium in water)	81.0	2.1	46.2	5.7	1.2	27.7	40.9	5.5
Millet hay, common or Hungarian	90.0	5.2	51.5	8.7	2.8	25.5	46.4	6.6
Oat hay	88.0	4 5	46.3	8.3	2.7	28.4	41.7	6.9
Oat straw	89.6	0.9	44.1	4.0	2.3	36.1	41.2	6.0
Orchard grass hay, early cut	88.6	4.6	49.6	7.7	2.9	30.5	40.7	6.8
Sorghum fodder, sweet, high in water	65.2	2.5	39.8	4.4	2.4	16.6	37.7	4.1
Soybean hay, seed developing	90.9	11.2	50.0	14.9	2.4	28.2	38.0	7.4
Soybean hay, seed well developed	90.8	11.9	53.0	15.8	5.1	27.2	36.6	6.1
Soybean straw	88 8	0.9	36.5	4.0	1.1	41.1	37.5	5.1
Sudan grass hay, in bloom	89.2	4.7	51.7	8.4	1.5	30.7	41.7	6.8
Timothy hay, before bloom	88.7	5.6	50.2	10.1	2.7	27.5	41.8	6.6
Timothy hay, early bloom	88.7	4.2	51.6	7.6	2.4	29.7	44.6	4.4
Timothy hay, full bloom	88.7	3.2	48.0	6.2	2.6	30.3	44.8	4.8
Wheat straw	90.1	0 8	35.7	3.8	1.5	35.7	40.9	8.2
Green Crops and Roots								
Alfalfa, green, all analyses	25.4	3.4	14.7	4.6	1.0	7.0	10.4	2.4
Alfalfa, before bloom	19.9	3.2	11.5	4.3	0.7	4.4	8.2	2.3
Beet tops, sugar	11.4	1.9	7.4	2.6	0.3	1.2	5.3	2.0
Beets, roots, sugar	16.4	1.2	13.8	1.6	0.1	1.0	12.6	1.1
Bluegrass, Ky., before heading	24.8	4.4	17.7	5.6	1.3	5.3	9.8	2.8
Bluegrass, Ky., headed out	36.4	2.8	21.0	4.9	1.3	10.9	15.6	3.7
Carrots, roots	11.9	0.8	9.6	1.2	0.2	1.1	8.2	1.2
Clover, alsike	22.2	2.4	13.2	3.8	0.6	5.8	9.7	2.3
Clover, medium red, in bloom	27.5	2.6	17.1	4.1	1.1	8.2	12.1	2.0
Clover, medium red, second crop	34.4	3.4	21.6	5.3	1.3	9.1	16.2	2.5
Clover, sweet, before bloom	24.3	3.4	15.6	4.4	0.9	6.3	10.6	2.1
Corn fodder, dent, in tassel	15.0	1 0	9.7	1.6	0.3	4.2	7.8	1.1
Corn stover, sweet, ears removed	21.5	0.6	12.3	1.6	0.4	5.6	12.6	1.3
Mangels, roots	9.4	1.0	7.3	1.4	0.1	0.8	6.1	1.0
Pasture grasses and clovers, mixed from closely grazed fertile pasture	28.7	4.4	20.6	5.7	1.1	6.4	12.8	2.7
Peas and oats	22.1	2.4	14.1	3.2	0.9	6.2	9.9	1.9
Potatoes, tubers	21.2	1.1	17.3	2.2	0.1	0.4	17.4	1.1
Pumpkins, field	10.4	1.3	9.0	1.7	1.0	1.6	5.2	0.9
Soybeans, before bloom	27.8	3.5	17.2	4.5	1.4	8.2	11.2	2.5
Sudan grass, in bloom or before	23.2	1.6	16.0	2.2	0.6	7.5	11.2	1.7
Timothy, pasture stage	22.8	3.7	16.0	4.7	0.8	4.2	10.4	2.7
Turnips	9.5	1.3	8.5	1.4	0.2	1.1	5.9	0.9
Silages								
Alfalfa, wilted before being ensiled	54.0	5.1	29.0	10.0	2.5	14.2	22.0	5.3
Alfalfa, high in water	23.9	1.9	12.7	3.7	1.4	7.4	8.6	2.8
Apple pomace	20.9	0.6	15.5	1.6	1.3	4.4	12.6	1.0
Beet tops, sugar	27.0	1.8	11.8	3.5	0.7	3.0	11.3	3.5
Corn, dent, well mature, all analyses	28.3	1.3	18.7	2.3	0.9	6.9	16.5	1.7
Corn, dent, well-mature, few ears	26.6	1.1	16.3	2.1	0.9	8.6	12.9	2.1
Corn, dent, immature, southern type	19.4	0.9	12.1	1.6	0.5	6.0	10.2	1.1

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TABLE VI.—AVERAGE COMPOSITION AND DIGESTIBLE NUTRIENTS *(Continued)*

FEEDING STUFF	Total dry matter	Dig. protein	Total dig. nutrients	AVERAGE TOTAL COMPOSITION				
				Protein	Fat	Fiber	N-free extract	Mineral matter
Corn, dent, stover-silage (ears removed)	22.6	0.8	13.6	1.5	0.6	7.7	11.3	1.5
Corn and soybeans, mostly corn	28.3	1.5	19.5	2.5	0.7	7.2	16.2	1.7
Corn, canning factory waste (husks, cobs, and waste ears)	22.4	1.1	11.5	2.0	1.0	5.6	12.8	2.0
Pea-vine, from canneries	27.9	2.6	17.8	3.5	1.0	7.8	13.1	2.5
Sorghum, sweet	25.1	0.8	15.1	1.5	0.8	7.0	14.2	1.6
Soybean	27.2	2.6	15.0	4.2	1.5	7.9	10.1	3.5
Concentrates								
Barley, common	90.4	9.3	78.7	11.8	2.0	5.7	68.0	2.9
Barley, malt	93.4	10.0	82.1	12.7	2.1	5.4	70.9	2.3
Beet pulp, dried	92.0	4.8	71.8	9.0	0.8	18.8	59.9	3.5
Beet pulp, wet	11.6	0.8	8.9	1.5	0.3	3.9	5.4	0.5
Blood meal, or dried blood	91.2	70.7	75.9	82.2	1.2	1.3	2.7	3.8
Bone meal, steamed	96.4	....	....	7.1	3.3	0.8	3.9	81.3
Brewers' grains, dried, 23 to 25 per cent protein	93.9	19.3	65.2	23.8	6.5	14.9	44.9	3.8
Brewers' grains, wet	23.9	4.6	16.6	5.7	1.7	3.6	11.9	1.0
Buckwheat, common	90.4	8.9	64.4	11.9	2.4	10.3	63.8	2.0
Buttermilk	9.4	3 3	9.1	3.5	0.6	....	4.5	0.8
Buttermilk, dried	92.2	32.1	85.5	33.8	5.6	0.4	41.9	10.5
Cocoanut oil meal, old process	90.7	18.7	80.8	20.8	8.2	10.4	45.0	6.3
Corn, dent, grade No. 2	85.2	7.1	80.6	9.4	3.9	2.2	68.4	1.3
Corn, dent, grade No. 3	83.5	7.0	79.0	9.2	3.8	2.2	67.0	1.3
Corn ears, including kernels and cobs (corn and cob meal)	88.5	6.0	75.9	8.2	3.3	8.2	67.4	1.4
Corn bran	90.1	5.7	74.4	9.8	6.4	9.8	61.8	2.3
Corn gluten feed, 24-27% protein	90.6	22.2	77.6	25.8	2.5	7.3	48.9	6.1
Corn gluten meal, below 43% protein	91.5	35.5	82.0	41.8	2.5	2.6	42.7	1.9
Cottonseed meal, 43% protein grade	93.5	35.0	75.5	43.2	7.2	10.6	27.0	5.5
Cottonseed meal, 41% protein grade	92.8	33.9	73.6	41.9	7.0	10.8	27.2	5.9
Cottonseed meal, 36-38½% protein	92.7	29.3	69.2	37.1	6.6	12.5	30.5	6.0
Distillers' corn grains, dried	93.6	22.3	85.0	30.6	10.6	10.8	38.7	2.9
Distillers' rye grains, dried	94.0	10.1	62.9	18.1	6.9	17.0	48.8	3.2
Distillers' grains, wet	22.4	2.9	17.2	4.4	1.5	2.5	13.3	0.7
Fish meal, 57-63% protein	92.2	48.8	67.7	60.2	7.5	0.8	3.9	19.8
Hominy feed	90.9	7.8	85.2	11.0	6.9	4.8	65.5	2.7
Linseed meal, o.p., 37% protein or over	91.2	33.5	77.8	38.5	5.6	7.5	34.5	5.1
Linseed meal, o.p., 33-37% protein	91.3	30.7	78.4	35.3	6.4	8.0	36.2	5.4
Linseed meal and screenings oil feed, 33% protein and over	91.4	29.9	75.7	35.0	5.7	9.0	35.9	5.8
Meat scraps, or dry rendered tankage, 55% protein grade	93.7	50.6	73.8	55.0	10.7	2.2	1.2	24.6
Milk, cows	12.8	3.3	16.2	3.5	3.7	....	4.9	0.7
Molasses, beet	80.6	2.5	58.8	7.7	...	....	62.6	10.3
Molasses, cane	74.1	0.9	56.6	2.8	...	....	61.9	9.4
Oats, not including Pacific Coast States	91.1	9.4	71.5	12.0	4.7	10.6	60.2	3.6
Oats, light weight	91.3	7.8	60.6	12.3	4.7	15.4	54.4	4.5
Oatmeal, feeding or rolled oats	91.5	14.7	92.5	16.3	5.9	2.8	64.1	2.4
Palmo middlings	94.1	13.3	85.4	16.0	9.6	6.7	56.5	5.3
Peanut-oil-meal, o.p., 45% protein and over	94.0	41.3	83.5	46.4	8.6	9.2	24.3	5.5
Rye grain	90.0	10.3	80.1	12.3	1.7	2.3	71.7	2.0
Skimmilk, centrifugal	9.6	3.5	8.6	3.7	0.1	....	5.0	0.8
Skimmilk, dried	93.8	33.1	84.1	34.8	0.9	....	50.1	8.0
Soybeans	90.2	32.8	86.2	36.9	17.2	4.5	26.3	5.3
Soybean oil meal, hydraulic or expeller process, 43-48% protein	91.9	37.6	82.8	44.2	5.6	5.2	31.5	5.5
Soybean oil meal, solvent process	91.6	39.4	77.6	46.4	1.6	5.9	31.7	6.0
Wheat, recent analyses	89.8	11.3	83.6	13.1	1.7	3.0	70.0	2.0
Wheat, bran & screenings, all analyses	90.8	13.2	69.5	16.1	4.9	9.6	54.2	6.0
Wheat, standard middlings & screenings	90.0	13.7	75.6	17.1	5.6	7.4	55.4	4.5
Whey from American cheese	6.6	0.9	6.4	0.9	0.3	....	5.0	0.7
Whey, dried (milk-sugar-feed)	95.0	11.9	84.1	12.5	0.7	....	72.1	9.7

Comparative Analysis of Common Feeds

The following table is designed to give at a glance the comparative analyses of the more common feeds. It also shows the characteristic amounts of dry matter and nutrients including the minerals, calcium and phosphorus.

TABLE VII.—Digestible Nutrients, Dry Matter, Minerals, Etc., in 100 lbs. Feedstuffs (Adapted)*

	Dry matter	Digestible Nutrs.		Fiber	Calcium	Phosphorus
		Crude protein	Total nutrients			
	%	%	%	%	%	%
Hay						
Alfalfa	90.6	11.0	50.1	30.1	1.43	0.21
Clover, Red	88.2	7.8	53.4	26.2	1.21	0.18
Soybean hay	90.8	11.9	53.0	27.2	0.96	0.25
Timothy	88.7	4.2	51.6	29.7	0.27	0.16
Succulent Feeds						
Bluegrass pasture	24.8	4.4	17.7	5.3	0.16	0.08
Corn silage	28.3	1.3	18.7	6.9	0.07	0.06
Grains, by-products						
Barley	90.4	9.3	78.7	5.7	0.05	0.38
Corn grain	83.5	7.0	79.0	2.2	0.01	0.27
Hominy feed	90.9	7.8	85.2	4.8	0.03	0.57
Oats	91.1	9.4	71.5	10.6	0.09	0.33
Wheat	89.8	11.3	83.6	3.0	0.03	0.43
Wheat bran	90.8	13.2	69.5	9.6	0.12	1.32
Wheat mids, standard	90.0	13.7	75.6	7.4	0.08	0.94
High Protein Feed						
Brewers' grains, dried	93.9	19.3	65.2	14.9	0.25	0.47
Corn gluten feed	90.6	22.2	77.6	7.3	0.14	0.55
Cottonseed oil meal 41% exp.	92.5	33.9	73.6	10.8	0.20	1.19
Distillers' corn grains, dried	93.6	22.3	85.0	10.8	0.05	0.31
Linseed oil meal o.p.	91.3	30.7	78.4	8.0	0.33	0.86
Soybean oil meal	91.9	37.6	82.8	5.2	0.28	0.66

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Other Bulletins on Feeding

Bulletin of the Agricultural Extension Service, Ohio State University, Columbus, Ohio:

No. 218 Utilizing Meadow Crops as Silage

Bulletins of the Ohio Agricultural Experiment Station, Wooster, Ohio:

No. 502 Preparation of Feeds for Dairy Cattle
538 Alfalfa-Timothy Hay for the Dairy Farm
Dry Feed Systems for Raising Cows (Reprint Bi-Monthly Bulletin 173, March-April, 1935)
Special Circular 49 The Mineral Needs of Farm Animals
" " 52 The Vitamin Needs of Farm Animals
" " 58 The Protein Requirements of Farm Animals